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Environmental Restoration Program at Technical Area 54**

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**EARLY IMPLEMENTATION
OF THE
LOS ALAMOS NATIONAL LABORATORY
ENVIRONMENTAL RESTORATION PROGRAM
AT TECHNICAL AREA 54**

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ABSTRACT

The Los Alamos National Laboratory (LANL) Environmental Restoration (ER) Program at Technical Area (TA) 54 is currently in the RCRA Facility Investigation (RFI) phase of an expanded Resource, Conservation, and Recovery Act (RCRA) corrective action program. Site characterization will focus on filling data gaps in a conceptual model constructed from existing information. An interim remedial measure involving vacuum extraction of a known organic vapor vadose zone plume will be modeled this year and hopefully implemented in fiscal year 1993. Long-term environmental restoration will probably involve vadose zone monitoring to confirm modeling predictions on the performance of existing disposal unit caps. However, it is possible that removal or *in-situ* treatment of some isolated "bad actors" will be necessary to ensure the long-term success of vapor extraction, or to remove surface hot spots that are unacceptably contributing contaminants to the surface water or air pathways. Public sentiment related to the long-term dedication of TA 54 as a waste disposal facility will have to be factored in early in the process to ensure that the most appropriate data are gathered during site characterization, and to instill confidence, both internally and external to LANL, that the ER Program Office is headed in the right direction at TA 54.

INTRODUCTION

The purpose of this paper is to briefly summarize the existing environmental challenges at Technical Area (TA) 54 and discuss preliminary thoughts on the approach to environmental restoration at the site within the context of the Los Alamos National Laboratory (LANL, or Laboratory) program. Environmental Restoration (ER) Program goals and the regulatory framework for conduct of the program at TA 54 are discussed first. Then, TA 54 is described and the technical and administrative approaches to environmental restoration are presented.

SPECIFIC GOALS OF ENVIRONMENTAL RESTORATION AT LANL

Obviously, the primary goal of the DOE Environmental Restoration Program nation-wide is to protect human health and the environment from releases of hazardous substances. This generic goal can be refined and specifically tailored to Los Alamos and TA 54.

Since the early 1970s, LANL has conducted a comprehensive environmental surveillance program designed to measure and document any effects that Laboratory operations may have had on the surrounding environment. The focus of this effort has been (and continues to be) on monitoring of environmental pathways available for the transport of contaminants to sensitive ecosystems and potential human receptors. Thus, the LANL Environmental Surveillance Program is suited to detection of present-day environmental problems so that mitigation efforts can be taken before any releases pose health hazards or threaten the environment.

In 1984, however, the Department of Energy (DOE), owner, and the University of California (UC), operator of LANL, recognized a need to be pro-active by instituting a program to identify past and present waste management units and other potential areas of concern that could pose environmental problems in the future. The goal of the Comprehensive Environmental Assessment and Response Program (CEARP, an ER Program precursor based on Superfund) Phase I Installation Assessment¹ effort was to establish a baseline for the conduct of a remediation program designed to complement the real-time efforts of the Environmental Surveillance Program by preventing possible future releases of hazardous substances to the environment. Consequently, the modern ER Program at LANL is focused on the identification and mitigation of anticipated future threats to human health and the environment.

However, another focus of the ER Program Office will be the identification of future intended land uses and the specification of preferred remedial alternatives accordingly. For example, areas that may eventually be unrestricted will have different cleanup goals than those where Laboratory operations are expected to continue indefinitely (e.g., certain material disposal areas). Even where future health or environmental effects are not anticipated, this secondary goal may drive the expenditure of funds for environmental restoration at LANL.

REGULATORY FRAMEWORK FOR CONDUCT OF THE LANL ER PROGRAM AT TECHNICAL AREA 54

Because LANL is a hazardous waste management facility with a Resource, Conservation, and Recovery Act (RCRA) operating permit, section 3004(u) of RCRA, which requires the mitigation of hazardous waste and constituent releases from solid waste management units (SWMUs), specifically applies. Consequently, the RCRA corrective action process, as proposed in the Federal Register², serves as the most appropriate regulatory framework for the LANL ER Program. However, because of the nature of TA 54, it is necessary to utilize other laws and regulations to broaden the scope of the ER Program and thus achieve the goals described above. The nature of the

RCRA law limits the applicability of the corrective action process specifically to releases of hazardous waste or constituents from SWMUs. Letter-of-the-law application of this requirement would necessitate that releases meet the legal definition of hazardous waste or constituent, and likewise, come from units that meet the regulatory definition of a SWMU. Thus, if the ER Program were to exclusively apply Proposed Subpart S regulations (which govern the corrective action process), a large subset of potential future problems could be neglected.

To illustrate this point, it is appropriate to examine two examples posed by TA 54 of this need to expand the regulatory framework beyond the RCRA corrective action requirements: 1) Overlap of corrective action requirements with RCRA closure regulations; and 2) releases of source, by-product, and special nuclear material. In the first example, several individual pits, trenches, and shafts within material disposal areas (MDAs or Areas) L, H, and G last received hazardous waste after November 19, 1980, the effective date of the RCRA hazardous waste regulations. Consequently, they became subject to the RCRA interim status treatment, storage, and disposal regulations, which include provisions governing their closure. Because authority to enforce these RCRA closure provisions has been delegated to the State of New Mexico Environment Department (NMED), whereas enforcement authority for the RCRA corrective action requirements for SWMUs remains within the U.S. Environmental Protection Agency (EPA), NMED has requested that EPA remove these sites from the list of SWMUs in the LANL RCRA Permit that potentially require corrective action. The purpose of the State request was to eliminate dual authority over a subset of disposal units within TA 54, and to guarantee that NMED remain the lead regulatory agency for sites subject to the delegated closure requirements. The result is that individual pits, shafts, and trenches located next to each other (less than 10 feet away in some cases) are simultaneously under the authority of two different regulatory agencies that may impose different technical requirements according to inconsistent schedules. Since September of 1990, LANL has cooperated with NMED and EPA to ensure that the cleanup approach adopted for TA 54 is integrated, consistent, and sensible, despite overlapping authorities. Consequently, the RCRA Facility Investigation (RFI) Work Plan for TA 54, currently under development, will serve simultaneously as an interim status closure plan modification.

The second example involves the cleanup of sites contaminated with certain radionuclides that meet the Atomic Energy Act definition of source, by-product, or special nuclear materials, which are specifically exempt from the RCRA definition of solid waste. Disposal of these wastes does not qualify the disposal unit as a RCRA-regulated SWMU, which means that a program based on RCRA alone could have a loophole large enough to omit one of the primary sources of potential future risk at TA 54: the Low-level Solid Radioactive Waste Landfill (MDA G). To solve this problem, the LANL ER Program Office will treat all radionuclides (as well as other hazardous substances not regulated by RCRA) as if they were RCRA hazardous constituents. For example, a Corrective Measures Study (CMS) will be conducted for sites contaminated with radionuclides above "action levels" that LANL has proposed and EPA and the NMED find mutually acceptable. Action levels for radionuclides and other hazardous substances will be proposed in the LANL ER Program Installation Work Plan. However, the RFI report or the CMS work plan for TA 54 may suggest alternative levels based on an assessment of site-specific conditions.

In summary, the LANL ER Program utilizes the RCRA corrective action process as a regulatory framework, but expands the scope in order to achieve the comprehensive goals of environmental restoration at TA 54.

DESCRIPTION OF TA 54

TA 54 (Figure 1) is situated on top of the eastern reach of Mesita Del Buey, one of the many finger-like mesas that comprise Pajarito Plateau. TA 54 has been one of the Laboratory's primary waste management (primarily storage and disposal) facilities since 1957. It consists of four discrete material disposal areas: Area G is the solid radioactive waste landfill and is also used for the storage of solid mixed and transuranic wastes; Area L is a hazardous waste treatment and storage facility that was used in the past for chemical waste disposal; Area H was used for classified waste disposal; and Area J is used to dispose of "administratively controlled" waste. Liquid radioactive wastes at LANL are treated in a central waste treatment plant prior to discharge in compliance with a National Pollutant Discharge Elimination System (NPDES) permit.

MDA G, the solid radioactive waste landfill shown schematically in Figure 2, consists of 31 pits, 4 disposal trenches, 162 disposal shafts, 34 retrievable transuranic waste storage shafts, and 13 solid PCB-contaminated waste disposal shafts, all in a 63 acre area. Approximately two dozen additional shafts are currently under construction. Siting and construction of Area G was assisted by the United States Geologic Service (USGS):

There are several basic factors to be considered. First, the Tshirege member (of the Bandelier Tuff, see Pathways, below) is a relatively impermeable rock and percolation from dry waste material...would be negligible. Thus the extent and depth of this impermeable cap should describe the limits of excavation. Second, as the thickest section of the Tshirege member occurs at the central axis of the mesa, construction of the pits might begin near the axis of the mesa and proceed toward the edge of the mesa to a minimum of 50 feet from the south cliff.⁴

In accordance with the USGS guidance, disposal units within Area G range in depth from 25 to 65 feet and do not extend beyond the Tshirege (upper) member of the Bandelier Tuff. Pits are generally about 400 feet long and 45 feet wide, and shafts range from two to six feet in diameter. The surface of some of the older pits is now being utilized for mixed and transuranic waste storage in dirt-covered mounds and tension support buildings.

Area G was originally intended to replace MDA C, located approximately 3 miles to the west, as an all-purpose landfill for potentially dangerous wastes⁴. In those early days, chemical wastes were rarely segregated from radioactive wastes. Consequently, the older portion of the landfill (to the east) poses a mixed waste problem, and is known to be the source of a vadose zone organic vapor plume³. Tritium vapors, in low concentrations, are also known to be migrating from some of the older disposal shafts⁵.

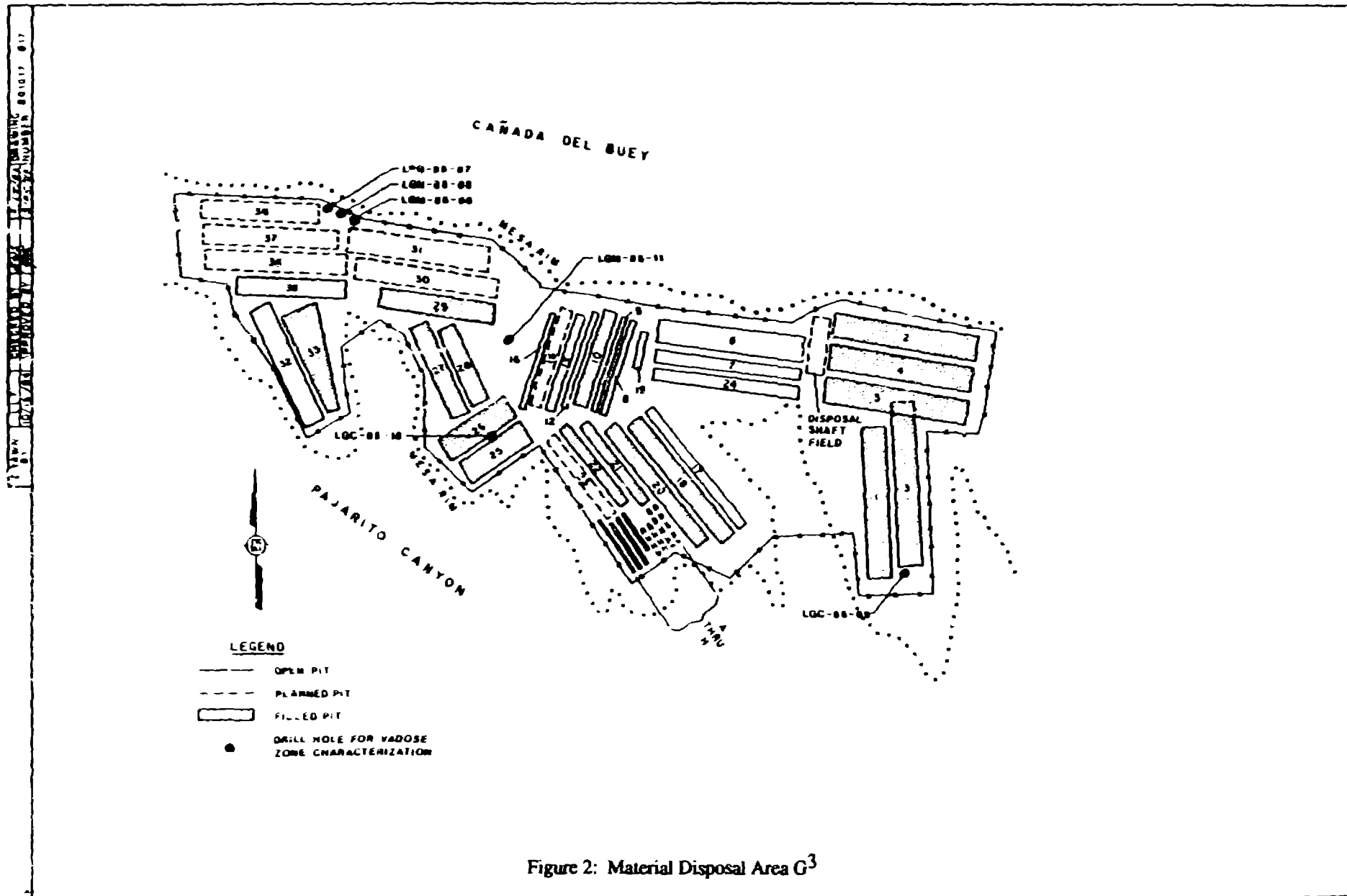


Figure 2: Material Disposal Area G³

Material Disposal Area L, about 1 mile west of Area G (Figure 3), became the chemical waste landfill for the Laboratory after it became clear that waste segregation was a wise engineering practice. From 1964 through 1975, all chemical waste (both treatment residues and untreated wastes) were disposed in Pit A. Beginning in June, 1975, the pit was covered and shafts, similar in construction to the Area G shafts, were used. Chemical waste disposal was discontinued at Area L in 1985, but the surface of Pit A and adjacent areas are still used for hazardous and liquid mixed waste storage.

Area L contains 34 shafts, three to eight feet in diameter and about 60 feet deep, all of which have been sealed with concrete. As illustrated in Figure 3, shafts were dedicated to the exclusive acceptance of one category of compatible waste materials. Although early disposal records are incomplete, it is known that prior to 1982 some liquid wastes were disposed without absorbents³. Area L is the source of a vadose zone organic vapor plume, consisting of approximately a dozen constituents, of which 1,1,1-trichloroethane is the dominant actor.

Areas H and J are located on the western edge of TA 54, across the street from each other (Figure 1). Material Disposal Area H was used for classified waste disposal from 1960 to 1985. It consists of nine shafts, similar in design to shafts at Areas L and G. Shaft 9 is known to have received 15 pounds of lithium hydride after 1980, making it subject to RCRA closure requirements. According to the waste disposal log, other hazardous and radioactive materials have also been disposed in Area H, and tritium is known to be migrating beyond the shaft boundaries in small quantities.

Area J has been used for the disposal of "administratively controlled" waste since the mid 1960s⁶. It consists of three pits (one of which is still being used) for disposal of wastes such as demolished structures formerly contaminated with high explosives (such wastes are flashed prior to disposal), treated barium-contaminated sand, and crushed empty drums which were previously used as packaging for hazardous materials. Additionally, two shafts for the disposal of classified waste exist at Area J, and the Laboratory stores asbestos waste in bins on top of the older, closed pits. No radioactive or hazardous wastes have ever been disposed at Area J, so it is not expected to pose any environmental problems. Consequently, Area J may be "written off" during the RFI phase of the corrective action process. However, since the first pit was capped in 1966, prior to the institution of rigorous waste segregation procedures, release investigations will be focused on this pit.

The Source-Term: What We Know and Don't Know

The primary sources of source-term data for TA 54 are cryptic, personal waste disposal logs, some of which have been lost over the years. For Area G, waste logs exist back to the first pit, excavated in 1957, but very little information of value can be obtained from these early logs. In 1971, DOE (then the Atomic Energy Commission, AEC) mandated better waste segregation, and better disposal records were kept as a result. It is possible to reconstruct radionuclide inventories by disposal unit from these newer records, and LANL has created a database for this purpose based on the modern-day Radioactive Solid Waste Disposal Request (RSWDR) form. The

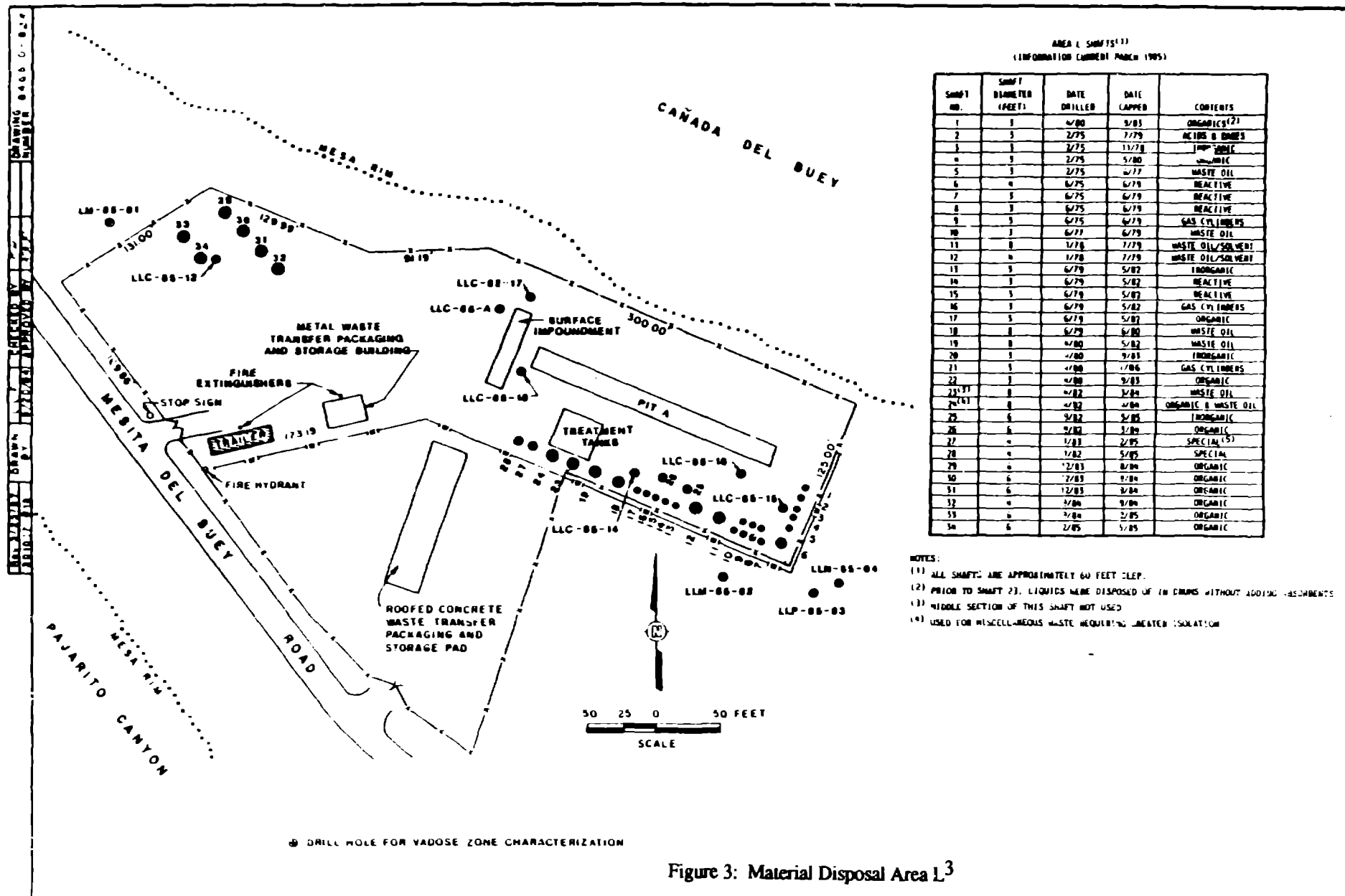


Figure 3: Material Disposal Area L³

RSWDR, still in use today, was instituted in the early 1980s and provides information critical to the accurate determination of a radioactive source-term (e.g., total curies, radionuclide, waste form, disposal location, etc.). For disposal units that were open prior to 1971, however, a far greater degree of uncertainty will be associated with the radionuclide inventory.

Furthermore, little to no information is available with regard to chemical waste disposal in Area G. Most of these wastes were disposed prior to 1964, when Area L opened, so only the older, cryptic logs are available. Reconstruction of the hazardous waste source in Area G will be difficult if not impossible.

The same problem exists for Area L. Some of the shaft disposal logs are missing, and those that exist are not very useful. A typical log consists of two entries: The date of disposal and a notation of waste type, such as "organics", or "waste oil". Quantities and specific waste constituents were hardly ever provided. To date, a log of disposal activities for Pit A, which served as the Laboratory's chemical waste landfill for 10 years, has not been found. However, there is documentation that indicates the intended uses of each shaft (wastes disposed in shafts were segregated by type as shown in Figure 3). Nevertheless, the large uncertainty in waste volumes and specific types makes it impossible to construct an accurate source-term model of Area L.

A single, formerly classified waste disposal log documents all of the waste disposal activities that occurred at Area H. However, again because of the cryptic nature of the entries, it will be difficult to reconstruct an accurate picture of the source-term.

Pathways and Releases: What We Know and Don't Know

The "Hydrogeologic Assessment of Technical Area 54, Areas G and L"³ compiled existing information on hydrogeological pathways available for the transport of contaminants. It also expanded the known database by reporting on the results of a limited field investigation, driven by a compliance order issued by the NMED in 1985. Some chemical characterization of the vadose zone was also conducted during the investigation, and it was during this effort that the organic vapor plumes emanating from Areas L and G were discovered.

The basic geology underlying TA 54 is illustrated in Figure 4. The depth to groundwater is about 875 feet below the land surface, and the hydrogeologic assessment report made several key conclusions regarding the potential for contaminant migration based on conditions found in the field:

The combination of very low moisture content in the tuff, empirical determination that moisture from precipitation does not infiltrate below a depth of ten to 22 feet, and very low calculated flux rates all suggest that aqueous transport of contaminants through Bandelier Tuff is not a viable mechanism for contaminant migration...

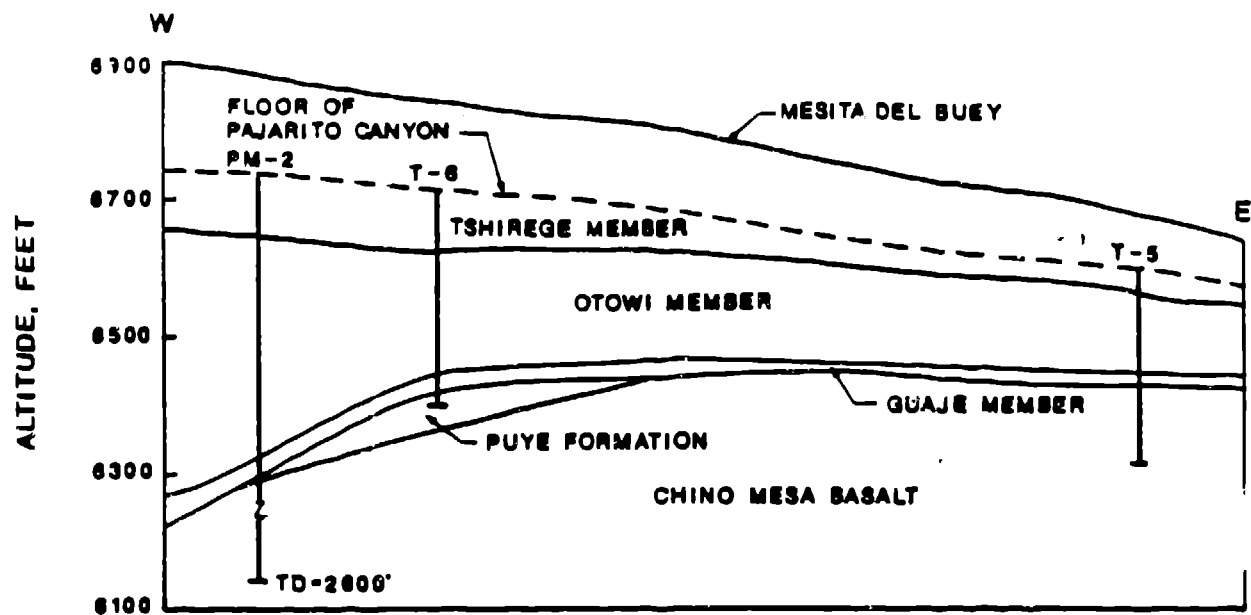


Figure 4: Generalized Geologic Cross Section of TA 54³

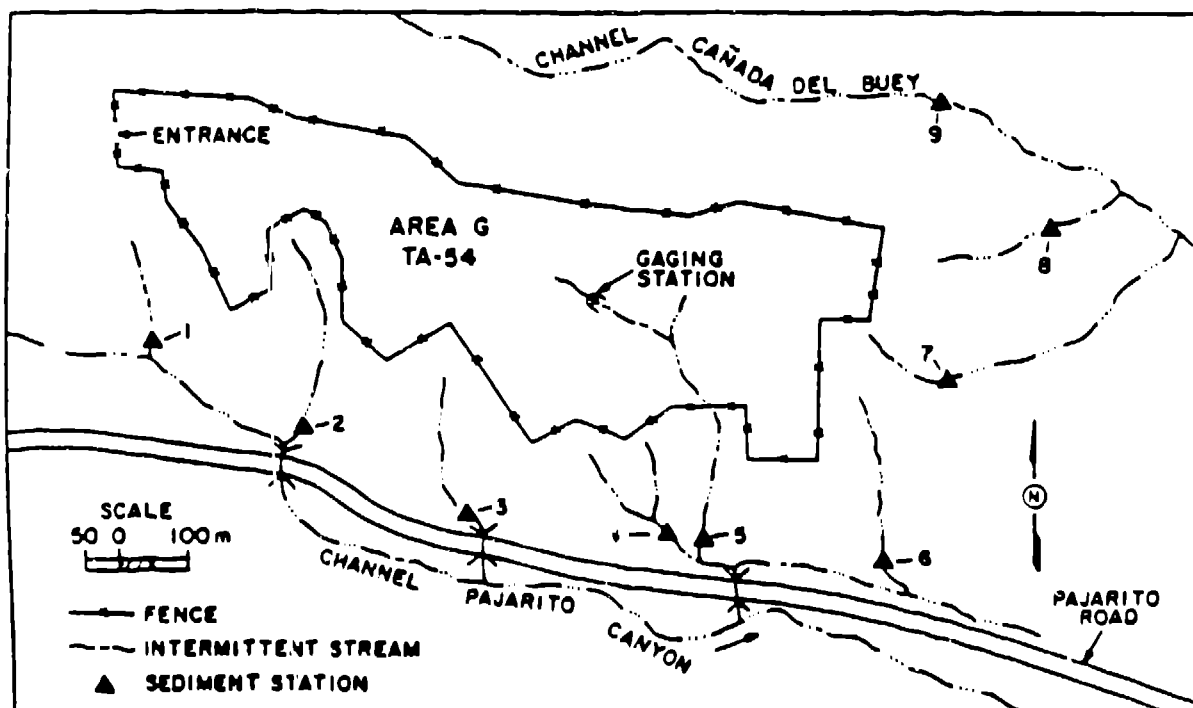


Figure 5: Sediment Sampling Locations Adjacent to Area G⁷

Volatile organic waste constituents have migrated...from the land disposal units at Areas G and L based on the results of core and pore gas analyses...Chemical data from the core and pore gas analyses (and information obtained from vadose zone characterization) support vapor phase migration from Areas G and L as the dominant transport mechanism...

No perched bodies of water, which could be hydraulically connected to the main aquifer, have been detected...Perched water in Pajarito Canyon (bordering TA 54 to the south) is confined to alluvium within the canyon and does not extend vertically or horizontally into the Bandelier Tuff which forms Mesita del Buey...There is no evidence of migration of hazardous waste constituents from Areas G and L into the perched water contained in the alluvium of Pajarito Canyon.³

Since this study was completed, the Laboratory has expanded the chemical characterization of TA 54 by installing an extensive pore gas monitoring system to define the vertical and horizontal extent of the vapor plume. The plume is now bounded. It extends through the Bandelier Tuff and appears to be confined vertically by a layer of weathered basalt, 250-300 feet deep in places. Areally, the primary plume extends some 200 yards east and 50 yards west of Area L. The Area G plume is much smaller. It is unknown whether Area L is replenishing the plume or if it will naturally dwindle with time, remaining bounded by the basalt until it is flushed out by changes in barometric pressure. Resolving this issue will be one of the primary goals of the TA 54 RCRA Facility Investigation.

As dictated in the compliance order, the focus of the hydrogeologic assessment was on the unsaturated Bandelier Tuff. Little is known about the hydrologic properties of the underlying materials such as the basalt layers, the conglomerate, and the Toluque Formation. Long-term transport modeling, if possible, will require this information. Furthermore, data collection was specifically driven by a compliance order, and the certainty of the report's conclusions is similarly limited. ER Program site characterization will focus on the collection of data intended to augment, confirm, dispute, or otherwise establish a level of confidence in the report's findings.

In addition to the vadose zone vapor plume, Area G has elevated radionuclide concentrations in surface soil due to past and on-going operations, and certain shafts are releasing tritium vapors in low concentrations. The LANL Environmental Protection Group (HSE-8) has concluded based on routine monitoring (in compliance with DOE Order 5820.2A) that contaminant levels do not pose a human health threat via the surface water or air pathways⁷. Levels in air are typically less than 0.1% of the DOE's Derived Concentration Guides for controlled areas, and sediment radionuclide concentrations are generally below background. However, this is not always the case. For example, in 1986, the Pu238 concentrations at stations 6 through 9 and the Pu239 and 240 concentrations

at stations 6 and 7 (see Figure 5) were above background levels. The concentrations are low and do not pose any health or environmental problems⁷." Perimeter soil contaminant concentrations have been measured as high as 100 times typical background values, but the calculated maximum radiation dose to the public (typically less than 0.5 mrem to the bone surface) is inconsequential. The ER Program will evaluate and augment, if necessary, the HSE-8 database to support comprehensive transport modeling of the surface soil contamination. Any threats to the air and surface water (including sediment) pathways identified during the RFI may, in the end, precipitate environmental restoration activities at TA 54.

APPROACH TO ENVIRONMENTAL RESTORATION AT TA 54

The Technical Approach

On February 8, 1991, the general approach to environmental restoration at TA 54 was presented to representatives of the NMED, and favorably received. Short-term and long-term goals were established. In the short-term, the Laboratory indicated its intent to perform an interim remedial measure to clean up the vadose zone vapor plumes emanating from Areas L and G. Consistent with the goal of addressing future land use requirements, the vapor plumes will be vacuum extracted to permit excavation of additional solid radioactive waste disposal pits (Area G expansion). An interim measure can not be otherwise justified at this time based on environmental and health protection, since the data indicate that the plumes are isolated from sensitive environmental pathways, such as groundwater.

To assist in designing an optimized vapor extraction system, hydrogeologic and pore gas data are being used as input parameters into a three-dimensional, two-phase transport code called TRACR3D. Pore gas monitoring well data will be graphically represented to provide an accurate illustration of the existing situation. Then contaminant flow in the unsaturated tuff will be modeled assuming a variety of extraction scenarios that vary the number, depth, and locations of the wells, as well as the applied vacuum and other key variables. A geostatistician has been employed to assist in the modeling, and the effort will be completed this fiscal year. Construction is expected to begin in fiscal year (FY) 1993.

Comprehensive site characterization is also scheduled for FY 93. The work plan for characterization, under development this fiscal year and due to EPA on May 23, 1992, will present a conceptual model of TA 54 based on existing information, and will propose methods for filling any data gaps in the model. Data collection requirements will be identified using decision analysis methodology integrated with the development of data quality objectives for each piece of information to be gathered. Source-term data will be collected to the extent that they are required for modeling, and pathway data will be collected to augment or confirm existing information.

With the possible exception of a few isolated units identified as "bad actors" (e.g., they are continuing release source areas) and a few surface "hot spots", it is likely that results of the site characterization will lead to the

conclusion that the majority of waste disposed at TA 54 should be left in place and monitored over the long-term. This kind of determination, however, involves a value judgement related to future land use, which will require early, meaningful interaction with regulatory agencies and the public. Nevertheless, in the unlikely event that modeling indicates that existing caps will eventually prove ineffective at preventing aqueous phase transport, LANL is currently supporting pilot studies on various capping designs intended to enhance stabilization. If not critical for remediation at TA 54, these studies may prove invaluable for other material disposal areas at the Laboratory.

Project Management and Organization

To integrate ER activities with day-to-day operations of the facility, LANL has elected to maximize the use of internal resources, and subcontract only in areas where there is insufficient expertise or resources. Thus, subject-based technical teams, cutting across Laboratory directorates and divisions, have been set up as resource pools available to ER Program Project Leaders. Two such teams have been, or are being, formed for TA 54. The first team consists of an engineer, an environmental scientist/RCRA compliance expert, a geostatistician, and two transport modelers. This team has responsibility for design and implementation of the vapor extraction system under supervision of the TA 54 Project Leader, and has been given the flexibility to tap into existing commercial expertise in the area, if necessary.

The second team is partially assembled and will consist of a geologist, a decision analyst/statistician, a radiochemist, two transport modelers, a sampling/analysis expert, and possibly a hydrologist. Some of these positions may be filled by outside contractors. This team will have the responsibility for development of the TA 54 RFI Work Plan/Closure Plan Modification by the 5/23/92 permit deadline. Additional technical teams will be set up as needed, including several field investigation teams composed of contractor and subcontractor personnel.

The Project Leader will coordinate and supervise the two teams and interface with outside agencies and the public, and all ER Program work for TA 54 will be reviewed by a steering committee consisting of key waste management (HSE-7) personnel and RCRA compliance experts from within the Laboratory.

Depending on the results of the RFI, environmental restoration at TA 54 could take in excess of 10 years and may cost tens of millions of dollars. Effective management, well-defined and focused goals, and meaningful interaction with regulatory agencies and the public will ensure that DOE funding is justified and efficiently utilized.

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